Things of science

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TASTE

Unit No. 265

TASTE

This unit of THINGS of science consists of paper impregnated with phenylthiocarbamide, six specimens of materials to test your sense of taste and this explanatory leaflet.

What is taste? Why do some foods appeal to some and not to others?

There are many factors that contribute to a person's likes and dislikes in food. The taste buds in the tongue, the senses of smell and touch, temperature, flavor and texture of the food, cultural background, all play a part in producing the sensation commonly called taste.

However, there are really only four primary taste sensations salty, sweet, sour and bitter. All other true tastes are a combination of these.

What we may ordinarily call taste, may not be taste at all.

The fragrance of breakfast coffee percolating on the stove and the delicious aroma of frying bacon or broiling beefsteak add much to our enjoyment of their taste. If you hold your nose as you eat them, you may find that the tantalizing aroma does more than add to the flavor—it is the flavor. What you thought you

were tasting, you really were smelling.

Cold coffee, when hot coffee is expected, is unappetizing, although chemically the constituents are the same. The pleasant fragrance associated with the taste of hot coffee is lacking.

Temperature also affects the taste of food and beverages. Did you ever let ice cream melt and then taste the syrupy liquid that resulted? If so, you may remember that it is much too sweet for enjoyment, although the frozen dessert is just right. Soup should be seasoned "to taste" at the temperature at which it will be eaten. Otherwise the cook is likely to find that she has put in too much or too little salt and pepper.

Familiarity and cultural background influence taste. Snails, frog legs, roasted grasshoppers and bird's nest are delicacies to those who are brought up in environments where such foods are served. While to others, these foods may have no appeal whatsoever.

There are a few materials that taste differently to different people. The most outstanding of these is phenylthiocarbamide (PTC). To most people it tastes distinctly bitter, but to about one out of three or four it is completely tasteless.

Experiment 1. First identify the specimens in this unit of THINGS of science.

SWEET—Lump of cane sugar in yellow wrapper, known chemically as sucrose.

SOUR—Citric acid crystals, illustrating the typical sour taste of acids.

SALT—Sodium chloride, the only material that produces a pure salty taste.

BITTER—Quinine, diluted with milk sugar to reduce the intensely bitter taste.

SALT AND BITTER—Epsom salt, magnesium sulfate, which produces a compound taste.

AROMATIC TASTE—Chewing gum, with its flavor due to smell as well as taste.

TASTE BLINDNESS PAPER—Impregnated with PTC which tastes bitter to some and is tasteless to others (white paper in envelope).

To identify the three packages containing the white crystals of citric acid, Epsom salts or quinine, taste a little of each and label according to your findings. You should have no difficulty in recognizing the different tastes. If you are uncertain about the bitter taste, Experiment 2 will help you out.

Experiment 2. You probably think you can identify all four of the primary tastes, but are you sure? Some people are so unfamiliar with strong bitter tastes that they mistakenly call them sour.

Taste a little of the quinine. Is it sour or bitter? Now drink water to get rid of the taste, then taste a bit of the citric acid. Did the quinine have a true sour taste as compared to the citric acid?

Experiment 3. As you eat your breakfast, think of the dishes that have a mild, bitter taste. The juice of grapefruit is sour, but the skin and the white lining are bitter.

Coffee without sugar is bitter. Burnt toast has a bitter flavor and so do some marmalades containing strips of orange or grapefruit rind.

Quinine is only one of many chemically unrelated substances that taste bitter. The specimen contained in this kit was diluted with milk sugar, lactose, so that it would not be too intensely bitter; also so that someone swallowing the entire sample would not get too large a dose.

Quinine is extracted from the bark of the tropical cinchona tree. Through the addition of sulfuric acid to the extract

quinine sulfate is obtained. This is the form in which the quinine appears in your specimen.

Experiment 4. Taste some of your citric acid. Then taste some of the sour substances that you may have around the kitchen such as lemon, lime and vinegar. Is the sour taste in them stronger or weaker than in the citric acid? Are they truly sour or a combination of tastes?

Citric acid was first obtained in the solid state from the juice of lemons. Most of the citric acid on the market today, however, is a commercial fermentation product. Your specimen was manufactured by growing a certain type of mold, a species of *Aspergillus,* on a medium containing glucose.

Experiment 5. Take your cube of Domino sugar and suck on it to get rid of the sour and bitter tastes. You undoubtedly could spot the taste of sugar anywhere, but how would you describe it to someone unfamiliar with sweets?

Your specimen of sugar or sucrose is an organic compound and was made from the sweet juice of sugar cane. Some sugar is made from the sugar beet. However, both sugars are the same chemically and taste just alike and look alike.

Look at your lump of sugar. It is composed of numerous little crystals formed when the sweet juice of the sugar cane, clarified and purified through several refining processes, was boiled under vacuum. The sugar crystals were then formed into tablets which were oven-dried to give them their shape.

Experiment 6. Take your packet of salt and examine the fine crystals. Table salt is in reality minute cubical crystals, like sugar, made by evaporating salt brine under vacuum.

When you place a little salt on your tongue, the salty taste comes from the sodium and chloride ions that are formed when the salt goes into solution with the moisture on your tongue. Both the sodium and chloride ions produce the salty taste.

Sodium chloride, common salt, is the only chemical that produces the true salt taste. Other salts, such as sodium bicarbonate and magnesium sulfate are a salty taste mixed with sour or bitter.

Since sodium is necessary for the growth of animals, herbivorous animals, those that thrive on vegetation alone, will travel great distances when necessary to reach an area where sodium salts are found. Although other minerals, such as

potassium, magnesium and ammonium give a salty taste, the animals will seek out only sodium salts.

Salt is essential in the human diet also and deficiency of this mineral can cause muscle cramps and weakness.

Experiment 7. In order for us to taste any substance, it must first go into solution. Look at your tongue and you will see that the surface is rough and covered with tiny little bumps. These are the papillae in which the taste buds are located. Each of the taste buds contains sensory receptors, spindle-shaped cells, for a specific taste sensation.

The sense of taste is a chemical sense, that is, the taste buds react to stimuli of a chemical nature.

In order for the substance to give a sensation of taste, it must reach the taste receptors through the opening in the papillae. To do this the food must first go into solution to reach the receptors. The chemicals in solution stimulate the receptors, and we taste salt, sour, sweet or bitter depending upon the substance. The taste receptors are specific for each taste.

If a substance is completely dry and is placed on a dry tongue and no molecules whatsoever of the material go into

solution, the object will be tasteless.

Experiment 8. Take a toothpick or similar instrument and dampen one end slightly. Dip the end into the salt and pick up a few crystals. Place the salt crystals on the tip of your tongue. Do the same on the sides and back of the tongue. On what section of the tongue do you find the greatest sensation of saltiness? Place a few grains of salt in the center of your tongue. Can you taste the salt?

Experiment 9. Repeat the experiment with citric acid, sugar and quinine and find the location on your tongue where the sense of taste for each is the greatest.

As you have found, the taste buds are distributed in clusters over the tongue and different sections of the tongue are more sensitive to certain tastes than to others. The tip of the tongue reacts to all of the four basic tastes, but more to sweet and salt. The sides of the tongue react to sour and salt, but are more sensitive to sour taste, while the back of the tongue responds to bitter stimuli.

You will find that the middle section of the tongue is almost completely without any taste sensation.

The taste buds for bitterness are the most sensitive of the taste receptors. Bit-

terness can be detected in concentrations many times less than those for sugar, salt or citric acid. Since bitterness is often associated with poison, this sensitivity may be nature's way of protecting man.

COMPOUND TASTES

Experiment 10. Taste a little of the magnesium sulfate (Epsom salt). Can you spot both the salt and bitter tastes? Epsom salt is an example of a compound taste. On what part of the tongue does the bitterness become evident? Magnesium sulfate is produced by the action of sulfuric acid on magnesite, a natural mineral composed of magnesium with carbon and oxygen.

Dissolve a little of your salt and quinine in a small quantity of water to see if the mixture tastes like the Epsom salt. Place a little of the mixture on the tip of the tongue. Do you taste both salt and bitter?

Saccharin produces a sensation of sweetness although it has no relationship to sugar. It is used as a sugar substitute, by some who cannot eat sugar. If you have some saccharin handy or can get a tablet from a friend, taste a little. You will discover that it is not just sweet,

but sweet combined with bitter. This explains why saccharin must be used in moderation. If too large a quantity is put into your tea or coffee, the saccharin will give the drink a distinctly unpleasant taste.

Experiment 11. The taste of many of the foods you eat is a combination of not just two, but three and even all four of the primary tastes. Taste sweet pickles, soup, spaghetti sauce and other foods to see how many of the simple tastes you can spot.

Experiment 12. Taste the quinine again, then immediately taste a little sugar or salt to see if the quinine has affected or deadened your ability to taste. While some substances are so mild they have no effect on the foods tasted immediately afterwards, others are quite intense and may change slightly the taste of foods that follow. They may even keep a person from tasting some of them. Smoking tends to deaden the taste.

Experiment 13. Some substances intensify the taste or flavor of other substances.

Salt, not only has a taste of its own but brings out other tastes. You are all aware of the flat taste of unsalted foods.

Taste a little unsalted soup or vegetables. Now add some salt to another portion of the same food and taste it. Note how the flavor of the food is brought out. Sprinkle a little salt on some sweet melon, if you have some, and notice how much sweeter it tastes.

Taste a little of your salt and wait a few seconds until the salty taste has almost vanished. Then taste sugar and notice how much sweeter the sugar tastes.

Conversely, the saltiness of food is enhanced by a sweet substance. Place a very dilute solution of salt on one side of the tongue. On the other side, place a small amount of sugar. Notice how the taste of salt is brought out as soon as the sweet sensation is produced.

Monosodium glutamate, a chemical taste enhancer, has little positive taste of its own, but it is used widely in cooking to intensify the flavor already present. If you have some available, add a trace to your soup or gravy and notice how this chemical enhances the flavor.

SENSE OF SMELL AND TOUCH AFFECT TASTE

Experiment 14. Take the sample of Dubble Bubble gum in your unit. Hold your nose and breathe through your mouth while you put the gum in your

mouth and chew it. Now let go of your nose so you can smell the fragrance of the gum and notice how much better it tastes.

The sense of smell is intricately related to the sense of taste. Without your sense of smell, or olfactory sense, food would lose much of its flavor, and some foods would have no flavor at all.

Sucrose, dextrose, corn syrup and a flavor blend with wintergreen predominating were added to the gum base to make it tasty and fragrant. A certified food color was used for the pink coloring.

Experiment 15. Prepare a little hot coffee and some hot chocolate. Then blindfold yourself, hold your nose (a snap clothespin will be helpful) and ask a friend to give you one of them to drink. Can you identify the drink without breathing through your nose?

Broil a small piece of ham and a similar piece of beef or lamb. Then again blindfold yourself and hold your nose. Can you identify the meat when your friend places a bit of one of them in your mouth?

Now blindfold your friend and ask him to hold his nose while you feed him a slice of onion and then a piece of apple.

Can he tell which is which?

Repeat the experiment with other foods and wtih food flavorings, such as vanilla and peppermint. Notice how much the flavor is due to fragrance.

When you have a cold and your nose is "stopped up," why do you suppose your food becomes tasteless and uninteresting? The above experiments will answer this query.

Experiment 16. Hold your nose and taste the salt, sugar, citric acid and quinine in turn. To be sure to get the pure taste of each, drink some water between each test. Does the cutting off of the sense of smell affect the four basic tastes?

Experiment 17. Feed your friend a piece of banana, pear and several peeled grapes. Can he identify them? If so, is it their texture that gives the clue? The texture of foods is important to the enjoyment of certain foods, such as the smoothness of ice creams and chocolates and the crispness of crackers. The enjoyment of the bubble gum in this unit also depends upon its texture in addition to its flavor.

These qualities have nothing to do with taste, but are intimately associated with it and are essential factors where food is concerned.

Experiment 18. If you have a little dextrose (corn sugar or grape sugar), taste it and notice that not only is it sweet, but that it has a cooling effect as well. Menthol, on the other hand, has a cooling effect but tastes bitter.

Experiment 19. Take a little cayenne or chili pepper and place it on the tip of your tongue. You would describe its taste as "hot." This sensation is due to the sense of touch, or the tactile sense, and has no relation to either taste or smell.

Receptors for the sense of touch are distributed on the tongue, palate and also on the lips and gums.

Tasters of wine do not swallow the fluid but roll it on the tongue to test its flavor and texture. The same is true in judging tea or coffee.

TASTE BLINDNESS

Experiment 20. Drink a little water so your taste buds can recover from the previous experiments, then tear off a little of the white paper impregnated with phenylthiocarbamide and chew it.

Can you taste the PTC? Do you get an immediate reaction or is it delayed? If you do not taste the small piece, tear off a larger piece and chew the two

together. Some who cannot taste a small amount do spot it in larger quantities.

About three out of ten persons find the material completely tasteless. A few have even reported it as sweet, sour or salt.

Experiment 21. Get some of your family and friends to try experiment 20. Explain to them that while to some this material will be tasteless, to others it will be bitter, sour, sweet or salt and let them describe the taste to you. Be sure, however, to have some gum, candy or sugar around just in case they find it intensely disagreeable.

Make a record of your findings. Try the experiment on as many people as you can and see how your statistics compare with what the scientists have found. Of course to make a truly reliable survey you would need a great number of cases.

If you do not taste PTC, you may discover that other members of your family likewise find it tasteless. This "taste blindness" is hereditary. If both parents are non-tasters, they will have non-tasting children. If either father or mother only is a taster, however, some of the children may be non-tasters.

Since about thirty years ago it has been known that certain substances taste bitter

to some people and are tasteless to others, and that this taste characteristic is inherited.

Dr. Arthur L. Fox working in the laboratories of Northwestern University discovered "taste blindness" when he was experimenting with phenylthiocarbamide, a chemical he considered completely tasteless. One of his associates complained bitterly of the taste when he inhaled some of the dust from this chemical. When others in the laboratory, to settle the ensuing argument, tasted the crystals, all found it as bitter as quinine. This curious difference in taste perception was first reported in April 1931 in the SCIENCE NEWS LETTER, a Science Service publication.

Dr. Albert F. Blakeslee, noted geneticist who at that time was associated with the Carnegie Institution of Washington read the SCIENCE NEWS LETTER article and recognized the possibility that PTC could be used in genetic research. He persuaded thousands of people to try the PTC and report their reaction. He found that the inability to detect the bitter taste in the crystals or weak solutions is inherited as a Mendelian recessive trait, and those who are "tasters" have inherited a

dominant gene that gives them this particular ability.

It has been found that among American whites, three out of ten are "blind" to PTC's bitter taste. The proportion is somewhat different for other races. The Chinese are reported to be 94% tasters and so also are the American Indians. This fact is used as evidence that the Indians originally came from Asia.

People have been found to be taste blind not just to PTC, but to a number of other compounds of the thiocarbamide group. They are all closely related to another compound, popularly called "dulcin," which is several hundred times as sweet as sugar. Another close relative is ANTU, a highly effective rat poison that is non-toxic to humans. In fact, it was in testing the taste blindness of rats that this powerful rat poison was discovered—all the subjects died.

Brucine, a cousin of strychnine and also poisonous, is bitter to the minority who taste it.

A person who is taste blind to one of these substances, however, may be a taster of others.

Experiment 22. There are a few other materials that cause different reactions.

Mannose, for example, is sweet to some, bitter to others and both sweet and bitter to still others. Sodium benzoate, a food preservative causes an even greater variety of reactions. Though many claim it to be tasteless, others report it to be sweet, sour, bitter, salt and a few "just plain awful." If either of these is available, try it on friends to get their reactions.

These experiments demonstrate that our abilities to taste things cannot always be compared. If you have something wrong with your taste buds, for instance, you do not get exactly the same tastes as your friends. Thus you may like a food your friends detest.

Our sense of taste plays an important part in our choice of foods and their enjoyment and ultimtaely our health, since it is what we eat that will determine whether we are well-nourished or not.

Several companies and associations cooperated to make this kit possible. The American Sugar Refining Company, New York, N. Y., supplied the lump of Domino sugar especially wrapped in yellow paper. The individual packages of salt

were contributed by the International Salt Company, New York, N. Y. The Dubble Bubble gum was furnished through the courtesy of the Frank H. Fleer Corporation of Philadelphia, Pa. The citric acid and Epsom salt were supplied through the generosity of Merck & Co., Inc., Rahway, N. J. The American Genetic Association, Washington, D.C., prepared the paper impregnated with phenylthiocarbamide especially for this unit of THINGS of science.

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Production by Ruby Yoshioka

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